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The sugar-beet and
beet-sugar

London

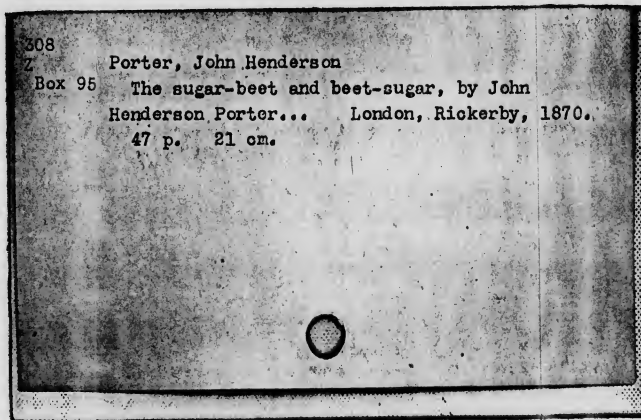
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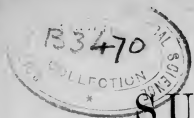
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THE

SUGAR-BEET

AND

B E E T - S U G A R .

BY

JOHN HENDERSON PORTER,

ASSOC. INST. C. E.

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dup

308
Z
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SUGAR.—“Any one who watches the course of events in the world will know that it is an article of the utmost interest. The state of tropical agriculture is one of revolution. Slavery is nearly abolished, and we know not exactly what is to take its place. . . .

“Of course, we know that the Beetroot industry of the Continent has got over its difficulties, and is spreading very widely. There is also the prospect of the growth of Beetroot with this object in our own country; and if we could hope for anything so good as that it should be introduced into the South of Ireland, it would be one of the greatest blessings that could possibly befall that country.”—*Vide the Budget Speech of the Right Hon. ROBERT LOWE, Chancellor of the Exchequer.*—“*The Times*,” 11th April, 1870.

LONDON :

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1870.

HAVING had opportunities of witnessing what has lately been doing in this country towards giving a business-like trial of the making of Sugar from the Beetroot, and having seen elsewhere the scale upon which this manufacture is conducted and the profits derived from it, the author of these few pages, impressed with the magnitude of the benefits attending the cultivation of this important industry, ventures to offer this contribution of facts and figures, old and new, in aid of the more valuable efforts of its abler advocates.

As there is a common disinclination to take up a pamphlet of many pages, one has to encounter the difficulty of condensing one's information and the reflections it gives rise to, that the truths to be disseminated may not fall on uncongenial soil; this, the author trusts, will be accepted as sufficient excuse for his not developing more fully the information at his command.

9, MINCEING LANE, LONDON,
April 21st, 1870.

00 Dec. 12, 1922

The Sugar-Beet and Beet-Sugar.

“EIGHT years ago, in 1862, the quantity of Sugar consumed in the United Kingdom was 9,379,818 cwt., or 36 lbs. per head of the population.

“In 1869, the quantity consumed had increased to 11,739,094 cwt., or 43 lbs. per head.*

“An Inland Revenue return shows that in the year ending 30th September, 1869, 41,980,949 lbs. (18,741 tons) of Sugar were consumed in breweries.”†

Of the 586,904 tons of Sugar consumed in 1869, about 80,000 tons were produced from the Sugar-beet, and imported from the Continent. The recent reduction, of one-half, in the duty on Sugar will naturally induce an increased consumption, and a larger importation of Beetroot Sugar.

Eighteen years ago, in 1852, there was presented to Parliament, in the form of a “Blue Book,” the Report by Sir Robert Kane, the Director of the Museum of Irish Industry, of an “Inquiry into

* The *Times*, April 2nd, 1870. † The *Times*, April 5th, 1870.

the composition and cultivation of the Sugar-beet in Ireland, and its application to the manufacture of Sugar."

A reference to this Report will show that it was based upon a number of experiments, by several lauded proprietors and others, on the culture of the Sugar-beet in various soils, treated with several kinds of manures; also, upon a series of carefully-conducted analyses by Professor Sullivan and Mr. Alphonse Gages, of the roots thus raised, and of the commercial value of their products in Sugar, and in feeding-pulp for cattle; and that it commented on the general bearing of the cultivation of this root upon the agriculture of Ireland.

In those days an attempt had been made to establish the manufacture of Beetroot Sugar at Mount Mellick, in Ireland; but—whether from want of good management, ignorance of essential details, insufficient capital, or from difficulty in inducing the farmers to grow, and to grow under suitable conditions as to manures, &c., a sufficient supply for conducting operations upon an economical scale—this attempt proved abortive, and no doubt discouraged others.

The Report, however, of Sir Robert Kane shows beyond possibility of doubt, by those who take the trouble to look through it, that there is nothing in the soil or climate of Ireland prohibitory of the success of this industry, for from

many sources it exhibits numerous specimens of the Sugar-beet rich in Sugar, and of a character equal to, not to say surpassing, that of the Sugar-beet grown on the Continent.

Eighteen years have passed since the publication of this unimpeachable evidence, but, notwithstanding that the increasing intercourse with the Continent has afforded us the opportunity of witnessing what has been doing there, slight heed has been taken, and but little done.

Let us see, then, what, during the eighteen years, or nearly so, through which this subject has lain dormant with us, has been doing on the Continent in the production of Beetroot Sugar.

In 1852, the quantity of Sugar produced in France was 70,000 tons; and in the same year a similar quantity was produced in the Zollverein.

In 1862, the production in France had increased to 175,000 tons, and in the Zollverein to 138,000 tons.

In this last season (1869-1870), eight years later, the quantity made in France is near to 290,000 tons, and in the countries of the German Union, 207,500 tons. Meanwhile, the cultivation of this industry has spread and grown in other countries also, until we find the produce of Russia 100,000 tons; that of Austria, 97,500; of Belgium, 40,000; while of Poland, Sweden, and Holland, the united produce is 45,000 tons.

In neither of the countries named does the consumption of Sugar, per head of the population, amount to one-half of that existing in the United Kingdom ; which is approached in that respect by the United States only.

A Trade Report of Mr. Licht, of Magdeburg, —an authority in the commerce of Sugars,—says, that “a further increase of Beetroot Sugar production may be expected for the next campaign, 1870-71, as, besides the extension of many of the present manufactories, we shall have to add to their total number ten to twelve new establishments in Germany, fifteen to sixteen in Belgium, and twenty in Austria ; a total increase of fifty-six to sixty new manufactories, not to speak of projected Russian, Polish, Dutch, and Swedish establishments.” Of France, Mr. Licht does not speak, but we read in the “Journal des Fabricants de Sucres,” of the 17th March, that “in taking account of twelve to fifteen new factories, of the new rasping-houses,” (of which more will be said further on,) “and the extensions decided upon of existing establishments, the production of the ensuing season cannot be estimated at less than 300,000 tons.”

The industry and carefully-trained intelligence of the countries here named have turned to good account the examples we have set them by our inventions and skill in the mechanical arts, and in all that relates to the steam engine, to railways,

and to the development of important manufactures. Embarrassed by our blockade of their ports, in days gone by, they were led to seek in the discovery made by Margraff, and utilized by Achard, a substitute for the produce of the Sugar cane ; their industry and science brought to bear in that direction have improved their husbandry, perfected their processes of manufacture, and made of the culture of the Beetroot a source of national wealth and power.

It would appear that we are less apt than they to profit by the example of an industry flourishing at our very doors, and somewhat at our own expense.

We plume ourselves, somewhat, upon our skill and excellence in husbandry ; our climate and soil are both suitable ; we have fuel cheaper than they have it on the Continent ; we have facilities of transport by land and water intersecting the country in all directions ; and as to labour, we are paying in agricultural districts in England from 10s. to 14s. per week to men, and it is hard to say how *little* to women and children ; we have thousands of our population living (or dying) upon less, and Emigration Leagues besieging the Ministry, and appealing to the public for funds wherewith to transport some of those thousands to distant lands.

Who will say there is any lack of capital ? Can it be that the profits on farming, as it is, are

already so ample as to make agriculturists indifferent to any source of additional gain that involves the slightest possible departure from a time-honoured routine? That is not consistent with the intelligent efforts and the scientific assistance brought to bear in these later days upon all questions affecting the economy of the farm.

Many of our large landed proprietors, possessing the capital for the establishment of the necessary buildings and machinery, could very well grow a sufficient quantity of roots for working upon a large and profitable scale. Smaller proprietors and tenant farmers combining for the same purpose, as they do on the Continent, could contribute, each a proportion of Sugar-beets, and each share to a corresponding extent in the proceeds of the manufacture.

Or where, in a suitable locality, contracts can be made with farmers for the supply of a sufficient quantity of roots for a term of years, it will answer the purpose of capitalists to set up an establishment for the manufacture of the Sugar.

SUGAR-MAKING IN SUFFOLK.

Happily we are not without an example. About three years ago one of our largest Sugar refiners, Mr. James Duncan, of London, having by very liberal offers prevailed upon the farmers in the neighbourhood of Lavenham in Suffolk to grow

the Sugar-beet from the seed he supplied, erected and fitted up there a factory for the extraction of the Sugar.

In the second season the factory was supplied with some 4,000 or 5,000 tons of roots, which it disposed of at the rate of from 50 to 60 tons per day. The farmers, well satisfied with the very liberal terms on which Mr. Duncan receives their roots and delivers to them feeding-pulp for their cattle, will no doubt very shortly enable him to conduct his operations on a larger scale. Those operations have already attracted much notice here, and not less on the Continent, whence, necessarily, Mr. Duncan has provided himself with his "plant" and skilled workmen.

Hitherto, he has stopped short of the production at Lavenham of the actual Sugar in a crystallized state; for, as the refiner has to reduce the imported Sugar to a fluid state by the addition of a proportion of water,—bringing it back, so to speak, to the state of syrup it was in at a previous stage of its manufacture,—Mr. Duncan, having purified the juice of his Sugar-beets, and evaporated from it so much water as to reduce it to the desired state of syrup, transports it in that stage to his refinery in London, where of Colonial and Continental Sugars he operates upon 500 tons per week.

The greater portion of the Beetroot Sugar manufactured on the Continent passes through the

hands of the refiners, but the author has not heard of this system having been adopted or tried there. Mr. Duncan argues that it not only obviates the provision of costly apparatus and machinery, and the larger buildings necessary for the reduction of the syrup to crystallized Sugar, and saves the cost of so reducing it; but, at the same time, there is also disposed of in the syrup, that which remains otherwise on the hands of the manufacturer in molasses or uncrystallizable Sugar.

The Continental manufacturers with whom the author has discussed this point do not agree that the system of transporting the syrup to the refiner (any considerable distance) could "pay;" they already produce at their factories a large proportion of their Sugar perfectly white and pure, and, in short, absolutely "refined," in large and brilliant crystals fit for the table, and still seek in further improvements to depend less upon the aid of the Refiner.

There is, no doubt, "much to be said on both sides;" it is not unlikely that, with our facilities of transport, Mr. Duncan's plan may often be the more economical.

By the kindness of its proprietor we were allowed to pass some days in November last in the factory at Lavenham, studying with a professional interest the processes in opera-

tion there; after which we availed ourselves of facilities afforded us of visiting some of the largest Sugar factories in France.

There, fortunate in the direction and guidance of M. Cail, of Paris, whose name is identified throughout Europe with the development of this industry, and in the Sugar-growing islands of the tropics, with many improvements in the manufacture of Sugar from the cane, we were enabled to study and admire, under the most favourable conditions, all the newest appliances and processes that the science of the chemist and the ingenuity of the engineer have contributed to perfect and economise the manufacture of Sugar from the Beet. Under these auspices, and confronted with the evidences of capital and skill associated in the employment of labour in a vast and productive field, no great effort of faith was necessary to accept the common dicta—that the cultivation of the Beetroot is of great advantage for the land and profit to the farmer, and that the extraction of the Sugar has built up large fortunes for those engaged in it.

In support of this may be quoted the remarks of Professor Voelcker, and Mr. H. M. Jenkins, of the Royal Agricultural Society of England, in their "Report on the Agriculture of Belgium; the result of a Journey made at the request of the Council," and published in the last volume (6th, part 1) of the Society's Journal (1870).

The same volume contains, also by Dr. Voelcker, an article upon "Beetroot Pulp," in which will be found an analysis of that produced at Mr. Duncan's factory at Lavenham, as well as the analysis of pulp from the Continent. A perusal of these Reports, from which some quotations will presently be given, will convey to the reader the sense entertained by the authors of the value of the industry we desire to advance.

This subject is also ably dealt with by Mr. Arnold Baruchson, of Liverpool, a gentleman intimately acquainted with the operations of the Continental growers and manufacturers of Beetroot Sugar, in a pamphlet issued by him in 1868.*

In the Report on the Agriculture of Belgium by Dr. Voelcker and Mr. Jenkins, we find, in reference to the "Rotation of Crops"—

"The best farmers have discovered that, after clover or roots, wheat is better than after another white crop; and, as the cultivation of Sugar-beet yields as large a profit as corn, they are at last reconciled to a fallow course of roots once in four or five years. The cultivation of Sugar-beet has, therefore, completely altered the best farming of this (the central) division of Belgium; and the rapid increase [recently noticeable in the number of Sugar factories shows that the improvement is being more widely extended.]"

* Edingham Wilson, Royal Exchange.

Also, "we must draw attention to the immense benefit which the 'Sucreries' confer on an agricultural district. It is not only that the crop is a profitable one to the farmer, and that Sugar-making is profitable to the manufacturer, but it is also that, at the dullest season of the year, agricultural labourers (men, women, and children) can earn in the factory, working piece-work, at least as good wages as in the summer,* when farming operations are in full swing."

CHARACTER AND TREATMENT OF THE SOIL.

The Report by Professor Sullivan and Mr. Gages, embraced in that of Sir Robert Kane, contains the following deductions from the experiments and inquiries at that time made; and as, in finding them confirmed by later authority and practice, we have nowhere found the information more concisely put, we transcribe them here:—

"PROPERTIES OF THE SOIL SUITED FOR THE BEET.—The soil should be a rich loam inclining rather to clayey than to sandy, but should not partake in the slightest degree of a peaty character—that is, the organic matter should be fully decomposed and thoroughly well distributed through it.

"It should be exceedingly well cultivated, and free from all clumps of hard clay, or from stones.

* Except during harvest, in some districts.

“ The subsoil should neither be a stiff cold clay, nor an open stoney gravel.

“ The soil should be deep, and drained as thoroughly as possible.

“ Newly-reclaimed land is unfitted for the cultivation of Beet for the manufacture of Sugar.

“ No labour should be spared upon the pulverizing of the soil, not only before the sowing of the seed, but during every period of the growth of the plant.

“ MANURES SUITED FOR THE BEET, AND THE MODE OF APPLYING THEM. — Rich nitrogenous manures, such as farmyard manure, guano, &c., should never be applied to land intended for the cultivation of Beet immediately before sowing, but should rather be applied with the previous crop, or applied during the preceding autumn, or at least should be put in as a winter compost. This rule applies equally well to all crops.

“ Soluble saline manures should be applied very sparingly, and never during the growth of the plant.

“ Salt should never be applied except with the greatest care, or any substances containing nitrates, or capable of forming them.

“ Ashes, such as those of wood, peat, coal, &c., may be employed, and bone-earth in any form, apparently without any injury.

“ Lime is always good, and calcareous soils seem to be the best adapted for the growth of all

the varieties of the Beet, and of most of the other root crops.

“ Green manuring has always been attended with success, and crops of rape, or of other plants, having the general composition of the Beet, may be grown upon land heavily manured in the autumn, with fresh farmyard manure, and then ploughed in early in spring.”

Table 6, “ which contains the results of analyses of several specimens of yellow globe, long red mangel wurzel, &c., grown on the same land, and in general manured in the same way as specimens of white Silesian Beet, supplied by the same gentlemen, is very suggestive.”

“ An examination of that Table shows that those crops which gave very large returns in weight give in general but poor returns in quality, a fact which is still more forcibly shown by Table 1. To take an example : Mr. M'Crea obtained 18 tons of white Silesian Beet per statute acre, and the Messrs. Dickson & Co. 46 tons. The average solid matter contained in the Beet grown by the former was 15·442 (per cent.), and in that grown by the latter 9·047.” Elsewhere, under the head of “ Effect of Increase of Size on the per-centage of Sugar,” — “ An examination of Table 1 shows in a remarkable manner that *the larger the root grown in the same field is, the smaller is the quantity of solid matter it contains.* Thus, No. 28 weighed 3 lbs. 9½ ozs., and yielded 14·383 per cent. of

solid matter; while No. 29, which weighed but 15 ozs., yielded 19·337 per cent. And as the percentage of Sugar contained in the dried matter does not vary very much, being, except under very peculiar circumstances, a little under or a little over two-thirds of its weight, it will be found that the quantity of Sugar will diminish as the weight of the bulb increases; No. 28, for instance, contains but 9·885 per cent. of Sugar, and No. 29, 12·132 per cent.”

Putting the question—“Whether is it better for the farmer to grow crops which give large returns, such as large red mangels, &c., or to grow crops like white Silesian Beet, which, although in general it gives a smaller gross produce, yields roots of superior quality?” Messrs. Sullivan & Gages answer it thus:—“We think we are justified in concluding that those who assume that because in some instances long red mangels have yielded a gross produce per acre exceeding that of the white Silesian Beet by 25 per cent., which is about the extreme limits, it must necessarily be the better crop of the two, do so without sufficient data. *In several cases that came under our observation, the balance was decidedly in favour of the Sugar-beet, and we are rather inclined to think that a thorough examination of the subject would, in general, show that good farming does not consist in producing immense roots, consisting of cells filled with water, but the largest quantity of solid food.*”

Turning now to the valuable paper by Professor Voelcker on “Beetroot Pulp,” we find the following analyses of the “composition of common mangolds and Silesian Sugar-beets, of fair average quality, grown in England:”—

	Common Mangold.	...	Silesian Sugar-beet.
Water.....	89·0	...	84·5
Sugar	5·5	...	9·5
*Albuminous compounds (flesh-forming matters)	1·5	...	1·5
Crude fibre.....	3·0	...	3·5
Mineral matter (ash).....	1·0	...	1·0
	100·0	...	100·0
*Containing Nitrogen ...	·24	...	·24

Dr. Voelcker remarks at the same time upon the difficulty attending comparisons between vegetable products, such as roots, as their composition varies exceedingly according to soil, climate, character of season, manure employed, and a variety of similar circumstances; but he believes the above statement to “represent correctly, and in round numbers, the composition of English common Mangolds and Sugar-beets of fair average quality.” He adds: “Speaking generally, the Silesian Sugar-beet grown in this country contains the same amount of nitrogenous compounds and mineral matters as ordinary mangolds, and from $4\frac{1}{2}$ to 5 per cent. less water, and nearly double the amount of Sugar which is found in common mangolds. The average per-centage of dry matter

in Sugar-beets is 15·5, and in common mangolds 11. A ton of the former, therefore, contains 347 lbs. of dry feeding substance, in round numbers, and a ton of the latter only 246½ lbs. Allowing only little for the superiority of Sugar as a fattening element of roots, *the case is far from over stated if 1 ton of English Sugar-beets is considered as equivalent in nutritive properties to at least 1½ ton of common mangolds.*”

It would appear, then, from the observations of Professors Sullivan and Voelcker, that, apart from the question of Sugar manufacture, and merely viewed in their crude states as food for cattle, an acre of 20 tons of white Silesian Sugar-beets is as valuable as an acre of 30 tons of mangolds, or mangelwurzel; the difference of 10 tons in weight merely representing so much more water, of which the 30 tons of mangolds contain 26·7 tons, and the 20 tons of Sugar-beets 16·9 tons; or, putting it in detail on the basis of the analyses by Professor Voelcker, on page 17, we have—

	MANGOLDS.	SUGAR-BEET.
	Tons. Cwts.	Tons. Cwts.
Sugar	1 13	1 18
Other solid food...	1 13	1 4
	3 6	3 2
Water	26 14	16 18
	<u>30 0</u>	<u>20 0</u>

The greater value of the 5 cwt. of Sugar in

excess in the white Silesian Beet is held to compensate the difference of 9 cwt. in the less nutritious properties of the “other solid food.”

The great Sugar-producing district of France is in the north-east, and adjoins that of Belgium, from which indeed it is divided only by an imaginary line; and the value of land and the price of labour do not greatly differ in these corresponding districts of the two countries. Taken together, these charges exhibit no advantage when compared with the same items in England. The prices paid to the farmer for the roots, and those realized by the manufacturers for the feeding-pulp they return to the farmers, are very nearly the same in France and Belgium.

Dr. Voelcker and Mr. Jenkins say that the rents in the central and eastern portions of Central Belgium are “generally from 40s. to 50s. per acre; but a farm on first-rate Sugar-beet land, especially if it includes some good grass, will be rented at 55s. per acre, or even more.” This is certainly prefaced by the remark, that “the rents, although extremely high, are not so heavy a burden on the farmer when compared with the productive power of the land . . . especially as most of the farms on the Hesbayan loam comprise a good proportion of rich grass, which is a very precious commodity in Belgium.” Moreover, “in some parishes, a farmer will have the option of taking a farm at a

certain rent, provided the root-course does not comprise Sugar-beet, or at an advanced rent if he intends to grow that root, the difference in price being often 10s. per acre, and sometimes as much as 15s. No doubt, by the growth of Sugar-beet, *without the purchase of pulp, or other feeding stuff*, a farmer might 'run out' the land to a most injurious extent by the expiration of his lease, and thus a premium is paid by *those who do not consume their own roots.*"*

There remains, however, the fact, that while paying a rent of 50 and even 55s. an acre, the farmer finds the Sugar-beet a very profitable crop.

Mr. Baruchson tells us (p. 29 of his pamphlet) that "the rent of land such as beet-growers need has steadily risen of late years (in France). Its usual price now is 200 frs. per hectare (about £3 per acre); and the selling value of estates has proportionately increased."

No doubt the farmer, selling his roots by weight, is interested in stimulating the growth of the plant for the production of a heavy crop, regardless of the probability that it may contain but a comparatively small per-centage of Sugar, and have derived from his manures other substances in excess, and to a degree exercising a most objectionable influence, not only upon the quantity and quality of the Sugar, but upon the cost of extracting it.

* Or, "other feeding stuff" ?

Now, as pure Sugar consists simply of carbon, hydrogen, and oxygen,* in certain proportions, it will be understood that the Sugar manufacturer, having two others of the elements to aid him, takes but little from mother Earth; his chief anxiety indeed being to disembarass his operations of the many substances she and the farmer together may put in action to disconcert him. Accordingly he does not accept every soil that is offered to him; and when he does find that which is suitable, he prefers to provide the seed himself, and stipulates for certain conditions in his contract with the farmer, as to the character and proportions of the manures to be employed.

M. Basset, in his work on the "Culture et Alcoolisation de la Betterave," quotes at some length the opinions of another eminent French chemist, M. Payen, who, on the subject of manures, speaks approvingly of "the method adopted generally, with great success, in the environs of Magdeburg, *of applying the manures at least a year before upon other cultures*, in order that the Beetroot may find them the more commingled with the soil, less active, requiring within a given time less oxygen for fermentation, and disengaging less carbonic acid."

M. Basset himself says, "One should not use dung for the Beetroot; the onion, bulbous plants,

* The oxygen and hydrogen are in the exact proportions that constitute water.

roots, are in the same case ; new dung does them great harm, and whatever may at first be thought of it, one goes near to losing both manure and harvest." And "the Beetroot sown for the Sugar factory should never be placed upon new manure ; it admits neither of guano, dried blood, 'poudrette,' nor any of those drugs in which azote is found more or less assimilated. That is associated with that which the Sugar manufacturer should avoid, above all, the albuminous products, of which the proportions are heightened by these sorts of manures ; the azoted substances render the manufacture very difficult, and impede the complete extraction of the Sugar."

And Messrs. Voelcker and Jenkins, writing of Belgium in 1869, say : "Sugar manufacturers do not like guano to be applied to the land for Beets, as it tends to give a bulky crop poor in Sugar."
 "What manufacturers prefer is to have the Sugar-beet grown after a well-manured white crop, such as wheat, to have little or no manure put upon the stubbles, and no artificial manure applied in any case."

So far, then, as the requirements of the manufacture of Sugar are concerned, there does not appear any reason for the land being exhausted by growing the Sugar-beet. Its cultivation involving the production of large quantities of cattle-feed, the feeding of cattle inevitably follows, and, with the feeding of cattle, the manuring

of the soil, and, with the manuring of the soil, a larger yield in corn.

FEEDING-PULP.

After giving the details of analyses of the Mangold, the Sugar-beet, and of the pulp from the latter, Dr. Voelcker adds, "In 100 parts of pulp it will be seen there are 30 per cent. of dry matter, whereas 100 of Sugar-beet, from which it is obtained, contain only $15\frac{1}{2}$ parts of dry substance, and common mangolds but 11 parts. A ton of Beetroot pulp accordingly contains 672 lbs. of dry matter, or 325 lbs. more than a corresponding weight of the roots, and $425\frac{1}{2}$ lbs. more dry matter than 1 ton of common mangolds."

"In other words, 1 ton of pulp contains, not quite, but nearly the same amount of solid substances as 2 tons of Silesian Sugar-beets, or 3 tons of common mangolds."

"Nobody probably will dispute the fact that the dry substance of a Sugar-beet or mangold is more valuable for feeding and fattening purposes than the dry substance of the pulp. The question, however, which requires to be settled is, not whether the perfectly dry pulp is less valuable than perfectly dry root, from which it is made, but whether the 672 lbs. of solid matter contained in

a ton of pulp are worth more or less than the 347 lbs. of solid matter present in a ton of Sugar-beet, or 246½ lbs. of the solid matter of which common mangolds consist."

And, further on,—“Taking all circumstances into consideration, I am inclined to think that accurate feeding experiments probably will prove that a ton of fresh Beetroot pulp, as it comes from the presses, or old pulp not containing more water than fresh, is worth as much for feeding purposes as 1½ tons of the roots from which it is obtained, or as much as 2 tons of common mangolds.”

In the “Blue Book” of 1852 there will be found the analyses of the pulp by Professor Sullivan, and, at page 66, the following conclusion:—“The result of these analyses would appear to point out that the value which ought to be assigned to the pulp, per ton, should be that at which the Beet was purchased.”

It is due, however, both to Dr. Sullivan and to the question of the value of the pulp of the Sugar-beet, to add, that he was at considerable disadvantage in not having at his command specimens of pulp from manufactories fitted with the powerful presses now in use, such as produced the pulp analysed by Dr. Voelcker. In his “First Experiment” on 26 cwts. of Beets, his proportion in pulp was 29·65 per cent., containing therefore a much larger per-centage of water than is found in

pulp from the factories. In his “Second Experiment” the proportion in pulp was 30·17 per cent., and contained, as it came from the press, 83·335 per cent. of water. No doubt also it contained more Sugar than if more of the juice had been got out of it at the press; nevertheless, there was obtained 6·51 per cent. of Raw Sugar, and 1·63 per cent. of Molasses, besides that left in the pulp. “The Sugar was of excellent grain, being fully equal to that sold under the name of Centrifugal Sugar, ‘although somewhat highly coloured.’”

Professor Voelcker says also,—“When Beetroot pulp has been kept for any length of time, it turns decidedly acid, and in that state is quite as much relished by cattle and sheep as when fresh. Practical feeders with whom I came in contact maintain that old pulp is superior to new for fattening purposes. Be this as it may, the lactic acid which is generated during the time of keeping certainly has the effect of preserving the feeding qualities of the pulp and of rendering it more digestible.”

“The plan of preserving Beetroot pulp in a good condition is extremely simple. All that is necessary is to dig a trench in the earth, to place in it the pulp, and to pile it up the same way as a heap of Mangolds or Swedes, and to cover the heaps with the earth from the trench. In this way the residue may be kept for years in a good condition.”

PER-CENTAGE OF SUGAR IN THE ROOT.

M. Payen gives something over 10 per cent. as a fair average per-centage of Sugar contained in the Sugar-beet in France.

M. Basset, in his criticisms on the Sugars displayed at the Exhibition of 1867 in Paris, speaking in high commendation of the Sugars from Prussia and the Zollverein says,—“If we add to what has been done the extreme care given to the selection of the roots, which contain often 14 to 16 per cent. of Sugar, it will be understood that beyond the Rhine they make of the Sugar industry a serious question, to an extent that we (in France) are far from being able to boast.”*

In Mr. Baruchson's pamphlet is a Table exhibiting the total weight of roots worked up, and the quantity of Sugar and Molasses extracted in each year from 1836 to the season 1864-65, in the Zollverein. This Table shows that for years past the Sugar produced at the factories has not been so little as $7\frac{1}{2}$ per cent., has often exceeded 8 per cent., and has attained (in 1860-61) to 8.62

* In France the duty (which is nearly four times as high as that Mr. Lowe has just reduced ours to) is levied upon the Sugar, while in Germany it is paid upon the weight of the roots delivered to the factory; consequently it is a matter of supreme importance to the German manufacturer to promote the growth of a maximum amount of Sugar in a minimum weight of root. Of course, he can afford to pay accordingly.

per cent. of the weight of the roots. This, be it understood, is crystallized Sugar; there remained still, in the shape of Molasses, the uncrystallizable Sugar, and in the pulp a further quantity.

Professor Sullivan and Mr. Gages say:—

“That the whole of the Sugar in the Irish Beet is crystallizable cane Sugar.

“That the per-centage of Sugar in Irish-grown roots is not inferior to that of Continental roots grown under the same circumstances.

“Table 1 contains the results of the examination of 118 specimens of the white Silesian Beet grown in Ireland. An analysis of this Table gives the following results:—

Of 118 roots, 12 contained above 12 per cent. of Sugar.		
9 between	11 and 12 per cent.	
19 ”	10 ”	11 ”
32 ”	9 ”	10 ”
18 ”	8 ”	9 ”
16 ”	7 ”	8 ”
2 ”	6 ”	7 ”
and 10 under		6 per cent.”

We read in *The Times* of the 13th April, 1870, that the Hon. L. Agar-Ellis, M.P., has lately, in the county of Kilkenny, grown Sugar-beets, from seed supplied by Mr. Duncan, containing 10.91 and 8.94 per cent. of Sugar.

With these facts before us we may venture to aspire to obtaining, as an average, richer roots than are taken by Dr. Voelcher—page 17—as a fair average specimen of English-grown Beets.

We are not demurring to his statement, for we are aware that the Sugar-beets *as yet grown in England* would hardly justify his assuming a higher standard; but knowing also how very recent has been the attempt to cultivate them at all here, and how much inducement had to be held out, both positively in the price, and negatively in the abstention from conditions that might have been deemed too exacting, we are not at all disposed to accept what has yet been done, under such circumstances, as the *ne plus ultra* of richness in Sugar.

With the skill and implements, and practical and scientific knowledge of the leading agriculturists of England, aided by such men as the authors of the Reports we have so largely availed ourselves of, can we yield the palm in this matter to France or Germany?

COST OF CULTIVATION.

With regard to the cost of cultivation, our English farmers, being already familiar with that of the "mangel wurzel," will not be very much at a loss; the Sugar-beet demands somewhat more attention during its growth *than is commonly given* "to the mangold."* There has

* It should be kept well freed from weeds; and well earthed up, that the "root" may not appear above the surface, for the heat of the sun is very detrimental to the formation of Sugar.

to be considered too, in addition to the cultivation, the cost of delivery of the roots to the Sugar factory, or it may be to some depôt at a wharf or railway station; the less, however, the roots are shifted and knocked about the better, for if bruised and caused to bleed, there is a loss of saccharine juice, or a deterioration in its character after being kept in store. In France the author saw in operation two systems lately introduced in order to obviate that risk, and to lessen the cost of transport. One was the overhead wire cable of Mr. Hodgson,* and the other the underground pipe-system of M. Linard; † the first transporting the roots, and the other conveying the juice. The cable was working over a distance of about two and a-half miles, and the pipes were bringing to a central Sugar-works the juice from distant farms, five, ten, and fifteen miles away.

The nearest approach that we have been able to make to the actual cost to those who have grown in Suffolk the Sugar-beets supplied to Mr. Duncan's factory at Lavenham is £11 per acre, which includes the cost of carting an average distance of three or four miles, as well as every kind of charge upon the land and every detail of farming.

* At the works of Messrs. Lallouette & Co., near Senlis.

† *Vide* page 43.

Mr. Duncan has paid, however, a very much higher price for the roots than is paid on the Continent, where, as we have seen, the rent of land is as much as £2. 10s. and even £3 per acre.

The average price there paid is 20 francs per 1,000 kilogrammes, or 16s. per ton; the residue or pulp being re-sold to the farmer at 12s. to 14s. per ton. At these prices the farmer will find a very handsome profit in growing Sugar-beet. The manufacturer could probably obtain a higher price for his "Pulp;" it would be valuable for feeding in towns where cows are kept.

Reverting to the "Blue Book" of Sir Robert Kane, we find, at pages 50 and 51, the following remarks and details, which can be criticised by those *practically* acquainted with such matters:—

"Being anxious to ascertain the system adopted in Suffolk, and the cost of cultivation in that county, we applied to Mr. William Raynbird, one of the authors of the prize essays upon the 'Agriculture of Suffolk,' and one whose opinion upon any matter connected with the green-crop cultivation in general agriculture is of the highest value, and he referred, in the kindest manner, to the essays of his brothers upon the 'Cultivation of the Mangel Wurzel.'

"According to Mr. Hugh Raynbird, the cost of cultivating one acre of Beet, including rent and taxes, and deducting value of leaves, is £9. According to Mr. George Edmund Raynbird, the

cost of growing one acre of Beet, including rent, and deducting value of leaves, is £8. 3s. 1d. We do not give the particulars of these estimates, as they have been already published, and must be well known."

"We are indebted to Richard Noverre Bacon, Esq., of Norwich, the author of the well-known able Report upon the 'Agriculture of Norfolk,' for the two following estimates:—

First Estimate of the Cost of Cultivating One Acre of Beet in Norfolk.

	£	s.	d.
Four ploughings at 5s.	1	0	0
Six harrowings " 1s.	0	6	0
Three rollings " 6d.	0	1	6
Balking the muck	0	2	6
Back-balking the muck	0	2	6
Carting mould from bottom	0	1	6
Carting long muck into the bottom, filling, and throwing off	0	4	0
Turning over muck heaps	0	1	6
Filling, carting, and spreading muck	0	6	0
Twelve loads of short muck, at 4s. per load ...	2	8	0
Drilling 1s., seed 4s.	0	5	0
Hand-hoeing, picking, horse-hoeing, &c., from 8s. to 15s., say	0	12	0
	<u>£5</u>	<u>10</u>	<u>6</u>

"To which should be added the rent, taxes, and the cost of harvesting, &c., less the value of the leaves, items which depend upon the locality and the amount of produce.

“ *Second Estimate of the Cost of Cultivating One Acre of Beet in Norfolk.* ”

	£	s.	d.
Three ploughings at 6s.	0	18	0
Two scarifyings ,, 2s.	0	4	0
Twelve harrowings ,, 6d.	0	6	0
Ridging up and closing, to cover manure ...	0	7	0
Twelve tons of farmyard manure and labour	3	0	0
Rolling, planting, and seed	0	7	0
Guanó and other artificial manure	1	0	0
Hoeing and singling	0	10	0
Cutting off tops and taking up	0	6	6
Loading, carting, and storing	0	8	0
Waste of straw to cover and covering up ...	0	3	0
	<hr/>	£7	9 6
Add rent, tithes, and taxes ... ..	...	1	12 0
	<hr/>	£9	1 6

“ From which must be deducted the value of the leaves, depending upon the amount of the crop.

“ According to Mr. Hugh Raynbird,* the value of the leaves of a crop of Beet at 20 tons to the statute acre, when fed off on the land or ploughed in green, may be taken at £1.

“ Mr George Edmund Raynbird† considers that the tops of a crop of seven and a-half acres of mangel wurzel, yielding 26 tons to the statute

* “ Journal of Agriculture and Transactions of the Highland and Agricultural Society,” March, 1851.

† “ Prize Essay, Journal of the Royal Agricultural Society of England,” vol. viii., Part I.

acre, would be fed off by 200 sheep in fifteen days, which, at 4d. per week each, would give 19s. 8½d. per acre.

“ The weight of the tops is very variable in all green crops, and especially in the Sugar-beet, as will be seen by reference to Table 7, appended to this Report; but taking the statement of the Rev. W. Huxtable, as given in the very admirable Report of Mr. Way, on the ashes of plants,* we find in the first instance that a crop of 24 tons per statute acre yielded five tons of tops, which, if valued at 3s. 4d. per ton, would be 16s. 8d.; another crop of mangels of 22 tons to the acre yielded about six tons, which, at 3s. 4d. per ton, would be £1.”

If, then, we assume as the cost of an acre of Sugar-beets, giving 20 tons of roots	£	9	0
And deduct for four tons of leaves ... ..	...	0	13 4

We have, as the cost of the roots trimmed ... £8 6 8

We have to add the carting to the Sugar factory, say an average distance of three or four miles at 6d. per ton per mile, say 20 tons at 6d. = 10s. per mile, for four miles

2 0 0

£10 6 8

The probability is that the *average* distance would, as a rule, be less than four miles, and the cost of the roots be proportionately less on that head. To some extent, too, the farmer may load

* “ Journal of the Royal Agricultural Society,” vol. viii., pp. 158, 159.

his carts back with feeding-pulp from the factory. Again, the Sugar manufacturer may provide traction engines, or there may be other means, such as have already been mentioned, of shortening the distance for carting.

However, whether the transport be undertaken by the farmer throughout, or only partially, let it be assumed that the carting is to the extent named in the foregoing estimate, and the cost per acre £10. 6s. 8d. In exchange for 20 tons of roots so delivered, the farmer would receive from the manufacturer £16 or £17, much indeed depending upon the price paid, on the other hand, to the manufacturer, for the "pulp," and the proportionate quantity of this latter to be taken back by the farmer in part payment. If in the proportion that the pulp bears to the roots, the quantity would be about four tons of the former to 20 tons of the latter; and, *if at the same price as paid for the roots*, the farmer would still appear to be the gainer in "kind."

Evidently, then, a great deal turns upon the value of the pulp; upon the proportion of pulp to be taken back by the farmer in part payment for his roots, and upon the price to be paid for it.

We have assumed that the cost of an acre of 20 tons of roots, after deducting the value of the tops and leaves, is, *upon the farm*, £8. 6s. 8d., or 8s. 4d. per ton. The farmer may thereupon argue that, allowing that a ton of pulp is equal

in feeding value to $1\frac{1}{2}$ tons of the roots, its value to him upon the farm would be no greater than the cost at which he produced $1\frac{1}{2}$ tons of roots, that is, 12s. 6d.

The manufacturer, on the other hand, will be likely to say,—“The market value of the pulp is one and a half times greater than the market value of the Sugar-beets, or double that of the common mangolds; therefore, if I pay you 15s. per ton for the Sugar-beets (that cost you 8s. 4d.), you should pay me £1. 2s. 6d. per ton for the pulp.” Of course, the law of “supply and demand” will regulate the “market value” of these two commodities. It is likely that in this country the manufacturer would often obtain a high price for the pulp for consumption in the large towns, but the matter would have generally to be adjusted with regard to the requirements of the farmer; and assuming that the manufacturer paid an average price, to include cartage to his factory, of 17s. per ton for the roots, it would answer his purpose to sell, and the purpose of the farmer to buy the pulp at the same rate, the farmer having to cart it home. It will answer the purpose of the farmer; for, although he can produce the equivalent of a ton of pulp in $1\frac{1}{2}$ tons of roots for 12s. 6d., he cannot afford to feed his cattle upon them, since by taking them to the factory he can get £1. 5s. 6d. for them, and obtain in exchange an equal amount of feed-

ing-stuff in the ton of pulp for 17s. His gain upon this little transaction, viewed by itself, is about 5s. 6d.; and as there are 4 tons of pulp in the produce of the acre of 20 tons, it amounts on the whole to £1. 2s.

The position, then, is this: if the 20 tons of Sugar-beets delivered at the factory cost the farmer £10. 6s. 8d., and he receives £17 for them, and the transaction ends there, his profit per acre is £6. 13s. 4d. But if he receive in part payment 4 tons of pulp at 17s., his total profit will be £7. 15s. 4d. Will there not be found in these figures a sufficient margin for any additions that may be thought necessary to be made, in some localities, to the estimates of cost upon which they are based?

In treating of the cost of cultivation, we began by referring to the roots supplied to Mr. Duncan, in Suffolk, and, finding to our hand other estimates from the same county, and that adjoining, we gave them as they appear in the "Blue Book," passing over, in doing so, the estimates there given also of the cost of raising the Sugar-beet in Ireland.

Those estimates (detailed) are by Professor Murphy, William Sinclair, Esq., William Dargan, Esq., and Lord Talbot de Malahide, and the result of their figures amounts to this: that, allowing that it costs on an average 2s. 6d. per ton to deliver the roots to the Sugar factory, the

first-named gives 11s., the second 9s. 9½d., the third, 7s. 8¾d., the last 8s. 0¼d. cost to him per ton of roots, delivered at the Sugar factory.

In the case of the first, the rent and taxes are taken at £2. 2s. per acre; in the two following, at £2; and by Lord Talbot de Malahide at £2. 4s.

COST OF THE SUGAR.

We have seen that the Germans obtain upwards of 8 per cent. of Crystallized Raw Sugar from their Beetroots, besides about 2½ per cent. of Molasses, sold for the distillation of spirit. Let us rather limit the basis of our estimate at first to a yield of 6½ per cent. of Crystallized Sugar, and see its value in relation to the price we have assumed to be paid for the roots. The value of the Sugar is (irrespective of the duty, which will be the same on home-made as upon imported Sugar) about twenty-four shillings per cwt.; and at 6½ per cent., a ton of Beetroots would yield 1 cwt. 1 qr. 5½ lbs., or 1·3 cwt., and dealing as before with 20 tons of roots (as the produce of an acre), for which the manufacturer pays £17—

	£	s.	d.
The yield of 1·3 tons of Sugar @ £24 =	31	4	0
About 8 cwt. of molasses . . . , 5s. =	2	0	0
„ 4 tons pulp , 17s. =	3	8	0
Scums and other refuse,* for manure .	0	5	0
	<u>£36</u>	<u>17</u>	<u>0</u>

* Lime, animal charcoal, and vegetable refuse.

Against this result we have to set—

	£	s.	d.
Cost of 20 tons of roots	17	0	0
Cost of manufacture, including wages, fuel, and other materials, management and general charges, lighting, &c., averaging per ton	11s.	=	11 0 0
Rent of land for buildings, taxes, &c.	1s.	=	1 0 0
Wear and tear of machinery and buildings	1s.	=	1 0 0
	<u>£30</u>	<u>0</u>	<u>0</u>

This leaves a gross profit of £6. 17s. as interest upon the capital sunk in the buildings and machinery, and employed in carrying on the business, which is in active operation only for a third of the year.

None of the establishments visited by the author on the Continent were working a less quantity than 200 tons of roots per day, some very much more. Now, at 200 tons per day, the earnings of the factory upon the above figures would be £68. 10s., or for the 100 days of the season, say £6,850.

The cost of the buildings and machinery would be within £20,000, and it may be assumed that the command of a floating or working capital of a like amount would be required for four or five months of the year; so that, in round figures, £30,000 would represent the capital of the twelve

months, upon which we have to find our interest in the £6,850 earned by the factory. We find it exceeds 22½ per cent. per annum.

The foregoing estimate is based upon a yield of 6½ per cent. of Sugar. If we might hope to attain to 8 per cent., as the Germans do, though it were with a less weight of roots per acre, and with paying a higher price for them, we might find our calculation as follows, still taking 20 tons:—

	£	s.	d.
20 tons of roots @ 20s.	=	20	0 0
Other items as before		13	0 0
		<u>£33</u>	<u>0 0</u>
1·6 tons of Sugar @ £24	=	38	8 0
8 cwts. of molasses „ 5s.	=	2	0 0
4 tons of pulp „ 17s.	=	3	8 0
		<u>£43</u>	<u>16 0</u>

Thus, taking the roots at 20s. per ton, and still returning the pulp at 17s., there yet remains by the greater yield of Sugar a profit of £10. 16s., or upon 20,000 tons of roots, worked up in 100 days, £10,800, representing a return of 36 per cent. upon the £30,000 engaged in the business.

It will be seen that, to supply a factory on this scale, there would be required at least 1,000 acres of Sugar-beets, and that these would furnish at 6½ per cent.—

1,300 tons of Sugar.	. . . . .	£31,200	0	0	
4,000 tons of pulp	@ 17s.	=	3,400	0	0
	(equal to 8,000 tons of mangolds.)				
400 tons of molasses	@ £5	=	2,000	0	0
4,000 tons leaves and tops	" 3s. 4d.	=	666	0	0
Manures, refuse of factory			250	0	0
			<hr/>		
			£37,516	0	0

Cost of raising the roots @ £9 per acre	=	£9,000	0	0	
Cost of carting, taken @ £2 per acre	=	2,000	0	0	
Cost of manufacture of Sugar, &c., @ £13 per 1.3 tons, or per acre	=	13,000	0	0	
			<hr/>		
			24,000	0	0
			<hr/>		
			£13,516	0	0

£13,516 is the profit, then, that would be obtained upon the produce of the 1,000 acres of land in the case of the farmer becoming manufacturer also, or of the manufacturer renting land and farming it himself. In this case, of course, will have to be considered the capital required to "farm," as well as the capital (£30,000) required for the factory. Also, of course, in order to command 1,000 acres of Beet year by year, some 4,000 or 5,000 acres of land will be required under various crops; but each crop will, of course, bear its own charge in respect of capital. Therefore, if £10 per acre be held to be a suitable capital for working the farm,*

* The rent is already taken in the cost of the roots.

there would be interest on £40,000, in respect of land and factory together. Now, £13,516 equals 33½ per cent. upon that capital.

This is with the Sugar-beet at 20 tons to the acre, and yielding 6½ per cent. of Sugar.

The results herein arrived at are consistent with the assurance the author received from an authority, second, as a manufacturer of Sugar, on the largest scale, to none in Europe; namely, that the profits of three years had repeatedly proved equal to the whole amount of capital invested in the business. This gentleman indicated at the same time certain establishments, in which he himself is interested, as examples of that state of things.

Indeed, an instance has been named to us recently, in reference to the abundant yield of this last season's crop, of nearly one-half of the amount of capital being earned in the profits derived from the one harvest.

It should be mentioned, also, that in France, to which country the above statements refer, the yield of Sugar does not exceed 6½ per cent. of the weight of the root.

The cultivation of the Beet called "mangel wurzel" and "mangold" is already carried to the extent of occupying 287,000 acres in forty-one counties of England. We will leave to the agriculturist to say what profit per acre is derived, on the average, from the cultivation of the "mangold." We have given estimates of the cost of

Sugar-beet, and of the cost of making the Sugar from the Beet purchased at 17s. per ton, and yielding $6\frac{1}{2}$ per cent. of Sugar. We have also combined the two, and shown the profit derivable from 1,000 acres of land devoted to this industry to be £13,516, or £13. 10s. 4d. *per acre*.

If we imagine the 287,000 acres mentioned above given to the Sugar-beet culture, there would result, in round figures, one-third of the amount of cattle-food now yielded by the mangolds, 350,000 tons of Sugar, 100,000 tons of Molasses, and a profit of £3,879,092; being, we fancy, double the sum earned by the land under mangolds.

CENTRAL FACTORIES.

We have already spoken of the transport of the roots from the field to the factory as constituting an important item in the cost, and have alluded in passing to two systems brought into action to lessen the expense and inconvenience. Indeed, at first sight, the contemplation of the work to be done in carting would alarm many farmers; but a little consideration of the matter, and the adoption of a system in working, will dispel much of the difficulty. Nevertheless, it will always be important, in seeking a site for a factory, to have regard to this item in the cost of the roots and

fuel. As compared with France, our smaller area is so much more closely intersected by railways and canals as to present advantages in this respect, and for bringing roots from distances rather too great for carting, though it is desirable to have as few shiftings of the loads as possible. For the more economical working of the manufacture, the larger the scale upon which it is laid out the better; but the difficulty of feeding it, of course, increases with the magnitude of the works.*

At the establishment of M. Baroche, at St. Leu, we first saw in operation the system of M. Linard, by which a tributary stream of juice is brought from a "Raperie" or rasping-house at Clouy, a village on a table-land some seven miles distant. Here, in the centre of its surrounding farm, we found a small establishment, very well appointed, for the purpose simply of rasping down the roots, pressing the pulp between the newly-invented cylinders of M. Champonnois, † passing the juice thus extracted through a strainer, giving it a dose of lime, and despatching it, under a moderate

* The number of Sugar factories in France is about 460, and as the *average* quantity of roots worked up is thus about 100 tons per day, many are working on a smaller scale than that. Our own view is that from 100 to 120 tons per day, say, for the season, 500 to 600 acres of roots, is as small a scale as it is well to work upon.

† This admirable contrivance of M. Champonnois dispenses with three-fourths of the number of hands employed in the ordinary method of extracting the juice (by means of

pressure, through cast-iron underground pipes to the factory at St. Leu.

At the factory of M. Lefranc, at Flavvy-le-Martel, we found this system on a more extended scale. This establishment is termed an "Usine Centrale:" it not only works up within its own walls more than 200 tons of roots per day, but it deals with the juice of a still larger quantity flowing to it from three Raperies, distant respectively five, ten, and fifteen miles. This is, however, being surpassed by a giant establishment now in course of erection at Meaux, (Seine-et-Marne,) of which a description is thus given in the words of Mr. Ernest Baroche,* as we have ventured to translate them.

"The factory at Meaux will be all in iron,—in iron from the Exhibition Building (Paris, 1867), and, as by the stroke of a magician's wand, it will emerge from the soil a few months hence a miniature of the marvel so much admired in the Champs de Mars. From this year 60 or 70 kilometres (38 to 44 miles) of pipes will connect

hydraulic presses), and, if its action proves equally effective, must greatly economise and expedite the process.

Messrs. Clovis, Godin, & Co., at whose factory near Douai we saw these "Presses continues" working, with some improvements by M. Lachaume, on a much more extended scale than at Clouy, are advertising for sale all their hydraulic presses and pumps.

* At a dinner given to the Agriculturists of Meaux.—See "Journal des Fabricants de Sucre," 10th February, 1870.

the 'Raperies' of Jouilly, la Trace, Marcilly la Jonchère, and Conporay, and will assure to it to begin with 50,000 to 60,000 tons of Beetroot; a quantity which, with an extension of the subterranean pipe system, and with a certain development of the culture of the plant, will be increased to double or three times the amount a few years hence.

"At this establishment at Meaux, they will work up each day the produce of 25 to 30 hectares (62 to 74 acres), and will obtain 70 tons of Sugar. As to the pulp, the residue from the several rasping-houses, it will be sufficient to maintain or fatten a herd of 6,000 oxen."

"The Department du Nord (says M. Baruchson, 1868), which produces the largest quantity of Beetroot Sugar, at the same time raises and exports more wheat and cattle than any other. Of 90,000 hectares (225,000 acres) occupied by the farmers in a certain district, only 1,447 were formerly sown with Beet for the use of cattle; the number now is 21,405. Formerly 4,202 hectares of wheat were sown there; now 9,290, and the cattle have increased from 6,995 to 40,656. Various instances could be stated where land, which before it was introduced yielded 19 hectolitres of wheat an acre, now yield 27 or even more."

There is another product of the Sugar-beet we have only incidentally alluded to in speaking of

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